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Amelioration Digital Eye Strain by Daily Exercising Eye Muscle

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ABSTRACT

Purpose: To test the effectiveness of eye muscle exercise (EME) for improvement of vision acuities (VAs) and amelioration digital eye strain (DES) or computer vision syndrome (CVS) and asthenopia in children.

Methods: Prospective, comparative, non-invasive, pre-limited study was carried out in 30 DES children (12 females; mean age of 8.5 years old) with the VAs ranging from 0.1 to 1.0 decimal in right naked eyes; 0.5 to 1.5 decimal in left naked eyes. The device for EME utilizing eye movements in the 8 compass points, rotary movement and movements for alternating distant and near fields of vision to regulate and relax eyes was used for 10 min/time, 3 times/day in total 2 months.

Results: VAs ranging from 0.3 to 1.2 decimal in right naked eyes (p=0.001); and 0.5 to 1.5 decimal in left naked eyes (p=0.004) were significantly improved after EME for 2 months. Percentage of respondents reporting symptoms such as blurred vision from 97% to 30%; difficulty or slowness in refocusing eyes from one distance to another from 70% to 33%; irritated or burning eyes from 37% to 17%; dry eyes from 60% to 20%; eye strain from 83% to 23%; headache from 7% to 3%; tired eyes from 67% to 30%; sensitivity to bright lights from 20% to 13%; eye discomfort from 90% to 27% and double vision from 13% to 0% were reduced as well. Results revealed that EME ameliorated DES or CVS and asthenopia. **Conclusion:** Daily EME improves VA of children with DES/CVS and asthenopia. Following up 2 months, DES symptoms were ameliorated.

Keywords: Digital eye strain, Computer vision syndrome, Asthenopia, Eye muscle exercise, Eyespa

Abbreviations: DES: Digital Eye Strain; CVS: Computer Vision Symptoms; EME: Eye Muscle Exercise; VA: Visual Acuity

INTRODUCTION

The usage of digital device [1] has been increased considerably in recent years [2,3] in children [4,5], so that extensive daily use for learning, homework and game purposes as well as during leisure time is now normal at school and home. Digital eye strain (DES) or computer vision symptoms (CVS) [6-8] and asthenopia includes a range of ocular and visual symptoms [9,10]. Symptoms has two main categories: those linked to accommodative or binocular vision stress [11,12] and external symptoms linked to dry eye [13,14]. DES or CVS and asthenopia [15] is identified using questionnaires [16] or evaluations of parameters such as critical flicker-fusion frequency [17], blink rate [18] and completeness, accommodative function and pupil characteristics [19]. The management approaches for DES or CVS and asthenopia [20] include correction of refractive error, management of dry eye, interaction between accommodation and vergence [19], regulating screen breaks [21] and blue light-filtering spectacle lenses. New technology and developed method of Eyespa give the possibility of amelioration to children with DES or CVS and asthenopia. Eyespa utilizes eye movements in the 8 compass points, rotary movement and movements for alternating distant and near fields of vision to regulate and relax eyes.

This prospective, comparative, non-invasive, prelimited study tests the hypothesis of whether Eyespa is effective in DES or CVS and asthenopia or not.

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MATERIALS AND METHODS

Study design and patients

This prospective, comparative, noninvasive, prelimited study, supported by Asia Pediatric Ophthalmologist Association, was conducted by the Radiant Children's Hospital Group. The protocol and HIPAA compliant informed consent forms were approved by the ethics committee of Radiant Children's Hospital Group (Beijing, China). The parent or the guardian of each study patient was given a written informed consent.

Between October 2018 and March 2019, 30 participants (F=12, 40%) at the age 3 to 13 years old (mean age 8.5 ± 2.85) with DES or CVS and their visual acuities ranging from 0.1 to 1.2 (mean 0.56 ± 0.196) decimal in naked eyes were enrolled into this study at Beijing Radiant Children's Hospital. DES or CVS was identified by accommodation parameters, critical flicker-fusion frequency (CFF) and blinking characteristics. Participates were excluded if they had any measurable heterotropia in primary gaze at distance or near fixation in the prescribed spectacles or a documented history of strabismus; other concomitant eye or other systemic diseases that could impair vision. All participants had the parent or guardian maintain a calendar on which EME received each day was logged. The calendars were reviewed at follow up visits.

Ophthalmological examinations

Before they took part in the experiment, a comprehensive history was collected including the number and type of devices being used (including desktop, laptop and tablet computers and smartphones), viewing distance and gaze angle for each device, duration of use for each device, monitor size (for a desktop computer, number of monitors being used), the type of task being performed on each device, the size of the critical detail being observed during the task. The participants were carefully diagnosed for potential ocular pathological defects; and determined their refraction through mydriasis optometry.

Accommodation testing and vergence testing were performed including subjective amplitude of accommodation (minus lens), accommodative response at preferred working distance (Cross-Nott retinoscopy), monocular and binocular accommodative facility (± 2.00 lenses), negative and positive relative accommodation, near point of convergence, distance and near heterophoria (near to be performed at the preferred distance), presence of A- and V-patterns horizontal fixation disparity/associated phoria at preferred distance, vergence facility (using 12Δ base-out/3Δ base-in prisms), base-in and base-out vergence ranges and stereopsis. The visual acuity (VA) was assessed by crowded Chinese Tumbling E Chart. Imp. Improvement. The corneal light reflex test, cover-uncover test and alternated cover test were performed to assess the participants' ocular alignment. Percentage of respondents (n=30) reporting symptoms was showed in **Table 1** and detailed characteristics of those participants at the first day visiting was listed in **Table 2**. The VAs was recorded before and after 2 month, respectively.

Table 1. Percentage of respondents (n=30) reporting symptoms.

Symptoms	Before		After 2 months	
	No.	%	No.	%
Blurred vision	29	97%	9	30%
Difficulty or slowness in refocusing my eyes from one distance to another	21	70%	10	33%
Irritated or burning eyes	11	37%	5	17%
Dry eyes	18	60%	6	20%
Eye strain	25	83%	7	23%
Headache	2	7%	1	3%
Tired eyes	20	67%	9	30%
Sensitivity to bright lights	6	20%	4	13%
Eye discomfort	27	90%	8	27%
Double vision	4	13%	0	0%

Table 2. Demographic and clinical characteristics (n=30, F=12).

No.	Age	Before EME				After EME	
		Mydriasis eyes				Naked eyes	
		Right	Left	Right	Left	Right	Left
1	13	-1.00DS	-1.00DS	0.4	0.6	0.7	1.0
2	10	-1.50DS	-1.50DS	0.3	0.4	0.9	1.0
3	13	-1.50DS-0.50DCX80	-2.25DS	0.6	0.5	0.9	0.9
4	10	-0.50DS-0.50DCX145	-0.75DS	0.5	0.6	0.9	1.0
5	9	-1.00DS-0.25DCX90	-1.25DS	0.1	0.3	0.7	0.7
6	4	-0.25DS-0.75DCX150	-0.50DS-1.00DCX25	0.7	0.7	1.0	1.0
7	4	-0.25DS-1.00DCX95	-0.75DS-0.50DCX125	0.5	0.4	1.2	1.0
8	9	-1.75DS-0. 05DCX180	-1.75DS-0.50DCX170	0.4	0.4	0.8	0.7
9	10	-0.50DS-0.50DCX135	-0.50DS-0.50DCX35	0.6	0.6	1.0	0.9
10	11	-1.00DS-0.25DCX155	-0.50DS-0.25DCX10	0.5	0.6	0.8	0.9
11	11	+0.75DS-0. 75DCX165	+0.50DS-0.50DCX175	0.9	1.0	1.5	1.5
12	5	+0.25DS-1. 25DCX170	+0.50DS-1.25DCX180	0.5	0.6	1.0	0.9
13	3	+1.00.DS-1.00DCX180	+1.25DS-1.25DCX180	0.4	0.4	0.7	0.8
14	7	+0.75DS-2. 00DCX175	+1.25DS-3.25DCX175	0.5	0.5	1.2	0.9
15	6	-0.75DS	-0.25DS-0.50DCX175	0.5	0.5	0.7	0.7
16	11	-1.75DS	-1.50DS-0.25DCX165	0.6	0.8	0.8	0.9
17	9	-1.50DS	-0.25DS-0.75DCX180	0.6	0.9	0.7	1.2
18	9	-1.75DS	-1.50DS-0.50DCX165	0.5	0.6	0.7	0.8
19	11	-0.50DS	-0.25DS-0.50DCX135	0.5	0.6	0.7	0.8
20	8	-0.75DS	+0.50DS-0. 50DCX20	0.4	1.0	0.5	1.5
21	6	+0.50DS-0. 75DCX10	+0.50DS-1. 00DCX165	0.4	0.5	0.9	0.9
22	9	-1.00DS	-1.00DS	0.5	0.5	0.7	0.8
23	5	-0.50DS-0. 50DCX135	-0.50DS-0. 50DCX35	0.6	0.6	1.0	0.9
24	10	-2.00DS	-2.25DS	0.5	0.5	0.6	0.7
25	10	-1.75DS-0. 50DCX130	-2.00DS	0.3	0.3	0.5	0.5
26	8	+0.25DS-0. 50DCX5	+0.25DS-0. 75DCX175	1.0	0.5	1.5	1.0
27	8	-0.25DS-1. 00DCX180	-0.50DCX175	0.5	0.7	0.8	0.9
28	9	+0.75DS-1. 25DCX165	+1.75DS-2. 25DCX180	0.8	0.5	1.2	0.7
29	10	-0.50DS	-0.25DCX140	0.7	1.2	1.2	1.5
30	7	-0.75DS	-0.75DS-0. 50DCX5	0.4	0.7	0.6	0.8

EME TREATMENT

Daily EME by using Eyespa (model: DF-JY01, Beijing Tuoda Laser Equipment Co. Ltd. China, produced in 2017; No. of Trademark: 31651609; No. of patents: HK1230002 and CN2018209130 58.9) was performed 3 times/day × 2 months. Eyespa includes a head-mounted virtual reality 3D spectacle main body having a left eye camera and a right eye camera, and a shelving board facing the left eye camera and the right eye camera. A control circuit board is provided on the shelving board. The control circuit board is provided with a control chip, and a first LED matrix and a second LED matrix connected with the control chip. The first LED matrix and the second LED matrix, under the control of the control chip, light up according to a certain sequence in order to guide eye movements. Furthermore, a first three-dimensional landscape and a second three-dimensional landscape are provided in the spectacle main body, respectively facing the left eye camera and the right eye camera. Eyespa utilizes eye movements in the 8 compass points, clockwise and anticlockwise rotary movements and movements for alternating distant and near fields of vision **(Figure 1)** to regulate and relax eyes after reading and working in front of computers for a long time, and to improve coordination ability of eyes, realizing the effects of preventing myopia, improving vision and relieving visual fatigue. Eyespa can be widely adapted to a variety of people.

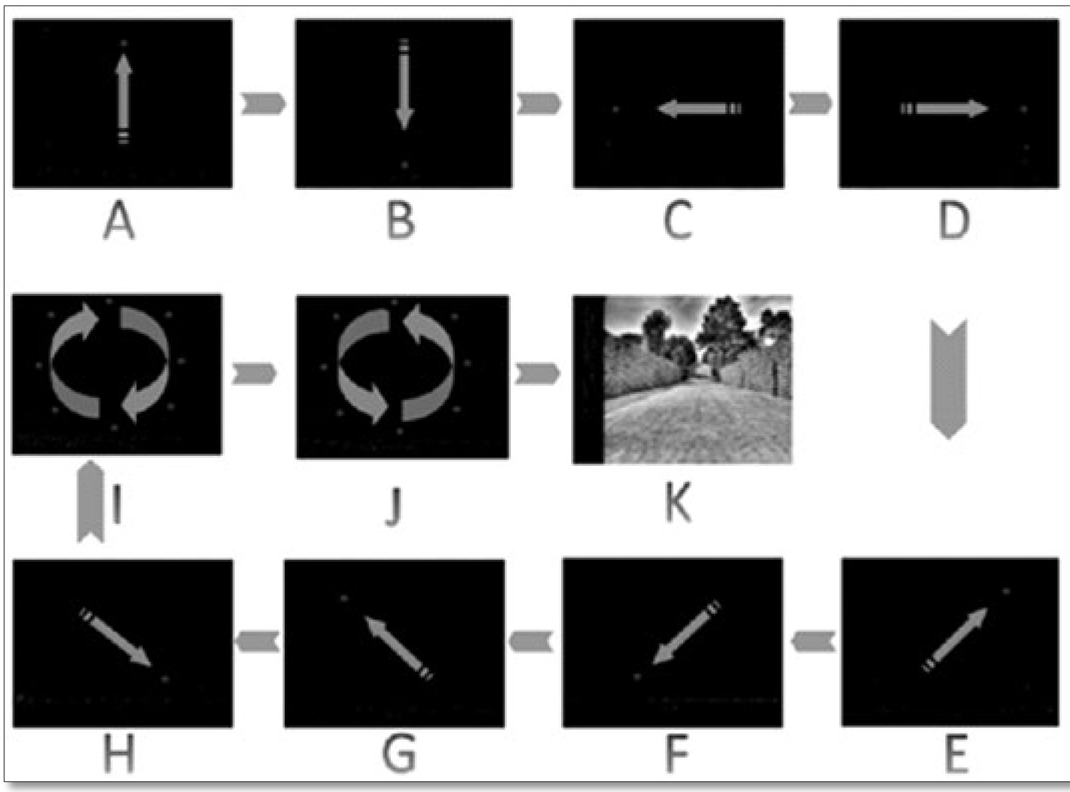

Figure 1. Eye movements in the 8 compass points, rotary movements and movements for alternating distant and near fields of vision.

DATA ANALYSIS

For each patient, the VA and symptoms were computed and assessed using analysis of two sample test. All reported P values were two-tailed. SPSS version 22 was used for analyses.

RESULTS AND DISCUSSION

Amelioration of DES/CVS and asthenopia

After 2 month Eyespa daily treatment, blurred vision symptom was improved from 97% to 30%; the percentage of difficulty or slowness in refocusing eyes from one distance to another was reduced from 70% to 33%; irritated or burning eyes were ameliorated from 37% to 17%; dry eyes were improved from 60% to 20%; eye strain was ameliorated from 83% to 23%; headache symptom was improved from 7% to 3%; tired eye was improved from 67% to 30%; sensitivity to bright lights were reduced from 20% to 13%; eye discomfort was improved from 90% to 27%; and double vision was reduced from 13% to 0% **(Table 1)**.

Visual acuity

The outcome examination was completed by 30 (100%) subjects. Visual acuities were significantly improved from average 0.52 ± 0.18 to 0.88 ± 0.26 decimal (P=0.001) in right eyes; and from average 0.60 ± 0.21 to 0.93 ± 0.24

decimal (P=0.004) in left eyes after 2 month Eyespa daily treatment **(Table 1)**.

DISCUSSION

In this prospective, observational study of 30 children with DES or CVS and asthenopia aged from 3 to 13 years old, we found that Eyespa treatment improved visual acuities an average of 0.52 ± 0.18 to 0.88 ± 0.26 decimal in right eyes; and from average 0.60 ± 0.21 to 0.93 ± 0.24 decimal in left eyes after 2 month Eyespa daily treatment. DES or CVS and asthenopia was ameliorated such as blurred vision symptom 97% to 30%; difficulty or slowness in refocusing eyes from one distance to another from 70% to 33%; irritated or burning eyes from 37% to 17%; dry eyes from 60% to 20%; eye strain 83% to 23%; headache from 7% to 3%; tired eye from 67% to 30%; sensitivity to bright lights from 20% to 13%; eye discomfort from 90% to 27%; and double vision from 13% to 0%. These results demonstrate that Eyespa therapy is an effective DES or CVS and asthenopia therapy modality, however, the sample size is not bigger enough. The double-blind clinic study is performing.

Reports on the application of EME daily treatment for the management of DES or CVS and asthenopia have been limited. In most of the reports, blue light-filtering spectacle lenses [22,23], lubricating eye drops[24, 25], correction of refractive error [26,27] the 20-20-20 rule [8], frequent short breaks [28,29] stimulating an exo-associated phoria [20], wraparound style of goggles [23] had been used, but no report of the daily EME treatment improved DES or CVS and asthenopia have been found according to our limited knowledge. The daily Eyespa treatment ameliorated DES or CVS and asthenopia by sensory motor function, however, we did not preclude that this therapy might also affect neuro-sensory improvements in the visual cortex.

Eyespa utilizes eye movements in the 8 compass points, clockwise and anticlockwise rotary movements, and movements for alternating distant and near fields of vision to ameliorate DES or CVS and asthenopia. With 3D imaging, binocular imaging and overlooking mitigation technologies, Eyespa can maximize the mobilization of the eyeball in all directions for enhancing the regulation and relaxation function as well as the elasticity of lens, restoring the regulation of ciliary muscle and alleviating visual fatigue.

This is an era that everyone extensive daily use digital device, even for children. They use digital device for learning, homework and game purposes as well as during leisure time normally at school and home. The big challenge is the prevention for DES or CVS and asthenopia. The strategy for management of DES or CVS and asthenopia involves ensuring an ergonomic learning environment [19,30]; patient education; visual examination; eye care; maintaining normal blinking; using artificial tears; improving contact lens comfort; using blue light filters; management of accommodation and vergence anomalies. Currently strategy for management of DES or CVS and asthenopia is great; and adding to use Eyespa in the strategy afterward is icing on the cake.

CONCLUSION

In the information age, digital devices have brought convenience to people, but extensive daily usages of digital devices in children are an impact on systemic and ocular health. Daily usages of Eyespa would make significant improvements for DES or CVS and asthenopia.

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